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Color Removal from Kraft Pulping Effluent by Lime Addition. Capsule Report

Environmental Protection Agency, Cincinnati, Ohio

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CAPSULE REPORT

COLOR REMOVAL FROM KRAFT PULPING EFFLUENT BY LIME ADDITION

U.S. ENVIRONMENTAL
PROTECTION AGENCY
INDUSTRIAL
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2 CAPSULE REPORT

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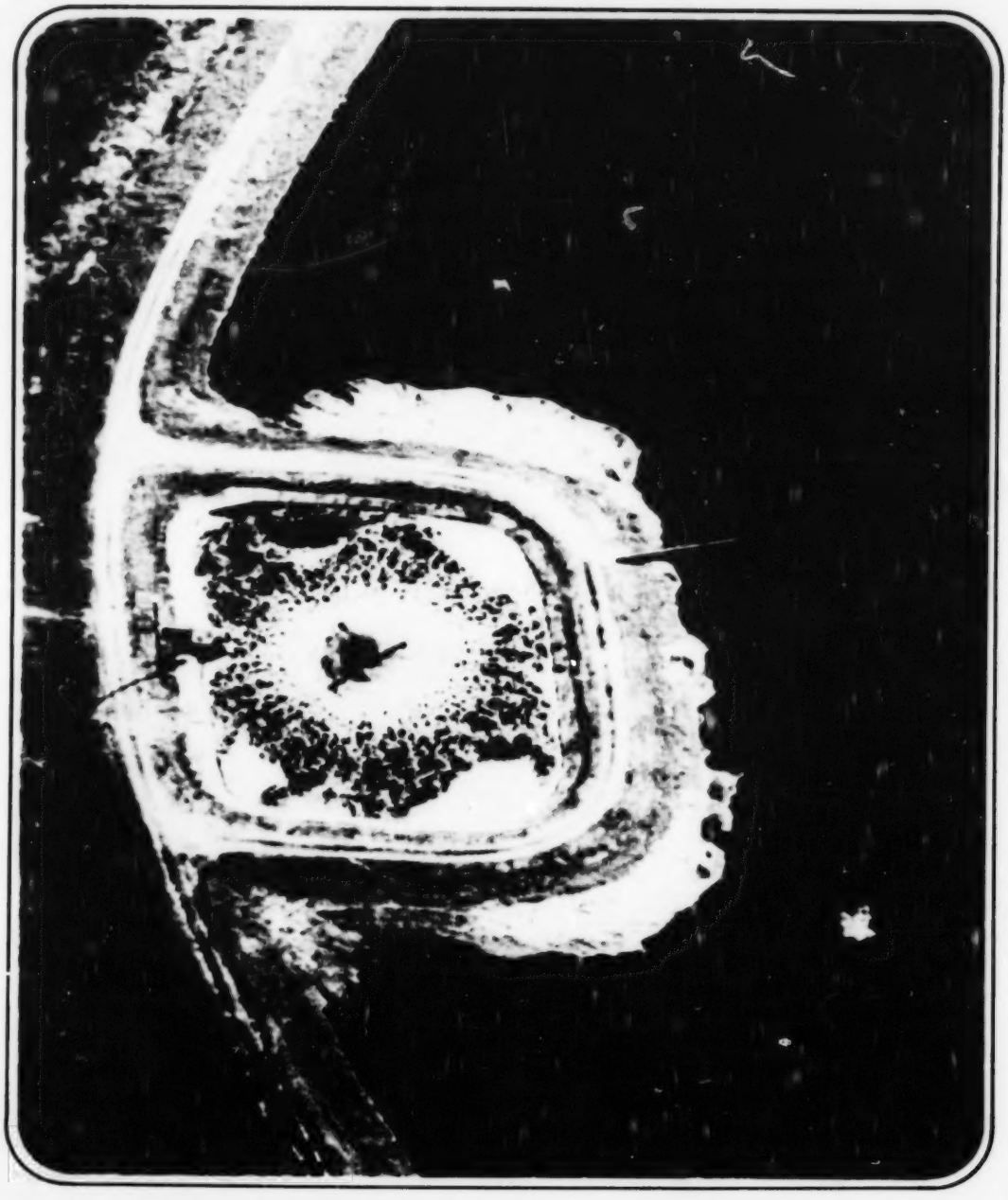
INDUSTRIAL DEMONSTRATION GRANT



Aerial View of Aeration Basin during Discharge

1. THE SIGNIFICANCE

Kraft pulp today represents the principal type of chemical pulp produced in the United States, accounting for 30 million tons, or 83 percent of the 36 million tons of chemical pulp produced in 1971. There are approximately 120 mills with a median capacity of 1000 tons per day manufacturing Kraft Pulp, concentrated in a broad arc of southern states ranging from Virginia to Texas, and in the Pacific Northwest, with lesser concentrations in the upper Great Lakes and New England states.

Discharge of a reddish brown colored effluent is invariably associated with its manufacture. While no national color pollution standards have as yet been developed to guide the development and application of kraft effluent decolorization technology, there are a growing number of locations where decolorization efforts have been requested by state or local regulatory authorities.

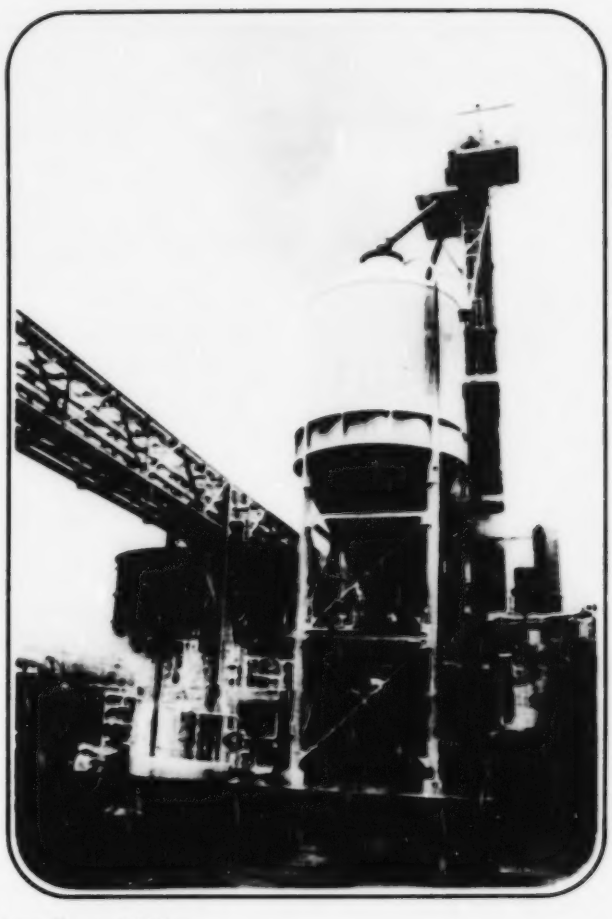
It has been known for twenty years that lime addition was capable of decolorizing kraft effluent, but intensified laboratory study in the last ten years has indicated that several alternate lime addition procedures are adaptable to colored effluents from either the pulping or bleaching stages of the kraft pulp production process. The use of lime is made more attractive by the existing major role occupied by lime in the kraft process pulping chemical recovery system, since it is already used in the recausticizing stage. This provides a dual opportunity for (1) recovery of lime used for decolorization and (2) destruction of removed color by conventional thermal oxidation processes.

The reaction mechanisms governing lime decolorization have been identified as precipitation of calcium salts of weak organic acids produced by chemical separation and fragmentation of wood-derived lignin during both pulping and bleaching.

In this EPA Demonstration Grant to Interstate Paper Corporation a full scale process for lime decolorization of kraft pulping total mill effluent was operated. Slaked lime addition was followed by primary sedimentation for removal of the mixed fibrous and lime decolorization sludges. The clarified effluent subsequently underwent biochemical stabilization in a quiescent storage basin. Neutralization of excessive lime alkalinity was achieved in this basin by absorption of atmospheric carbon dioxide. The grant also supported a pilot-scale study of recarbonation for enhanced lime separation and more rapid effluent neutralization prior to biochemical stabilization.

While 83 of the 120 kraft mills produce bleached kraft pulp whose effluent contains substantially more color per ton of product than that from the pulping process alone, the demonstration at the Interstate unbleached kraft mill has the following significance: (1) It demonstrated an effective decolorization process applicable to the 37 mills producing only unbleached pulp. (2) It provided a calcium-rich decolorized effluent for subsequent pilot-plant recarbonation investigations applicable to all effluents from lime decolorization processes. (3) it raised the possibility of bleached kraft total mill effluent decolorization by a similar lime treatment process, and (4) it laid the basis for additional studies of decolorization lime recovery in conjunction *with primary sludge disposal.*

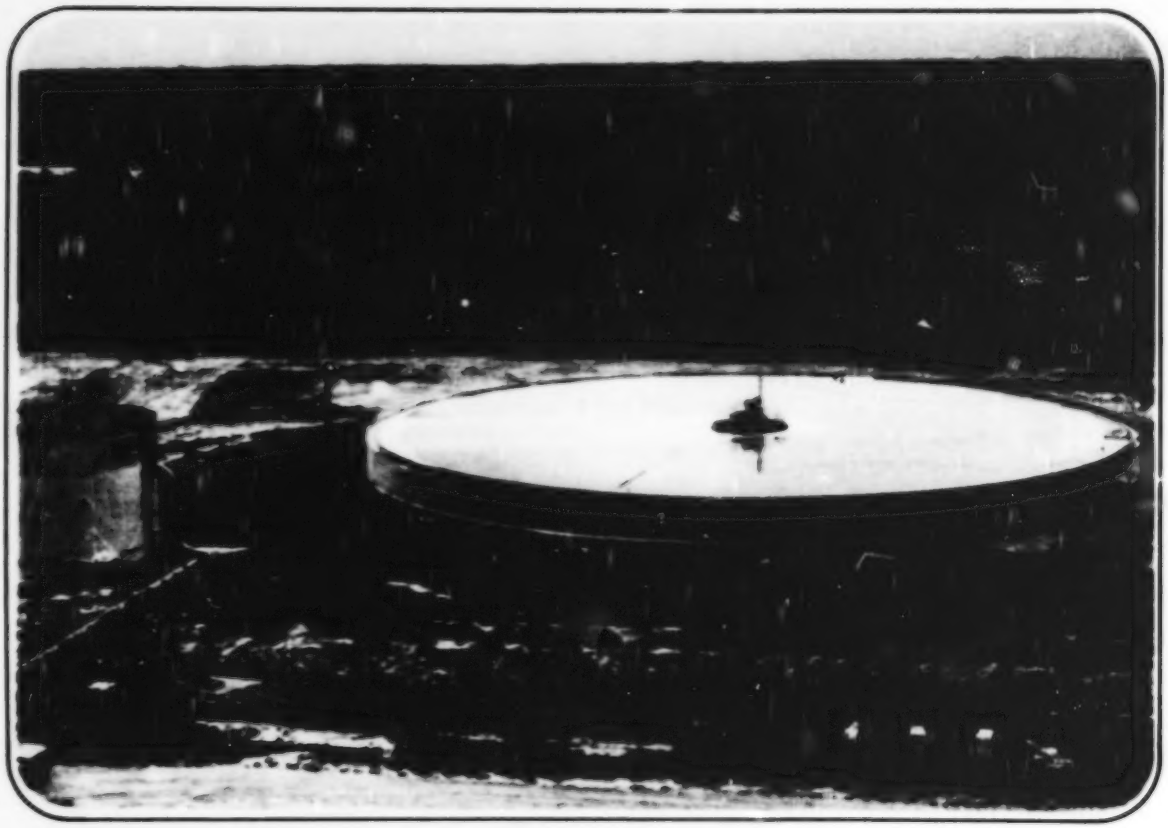
2. THE NEW PROCESS



Lime Kiln and Slaker

A *calcium* hydroxide dosage of 1000 ppm derived from a calcium hydrate slurry at 1.04 sp.gr. produced in a conventional quick lime slaker (S-1) is applied to a total mill effluent of 1200 APHA color. Following a 35 minute flocculation period (T-1) gravity clarification (C-1) at a rise rate of .13 gpm per square ft. clear rise area yields a decolorized effluent of 125 APHA units, and 10 ppm suspended solids. The clarifier underflow sludge contains 2 percent solids with diminished dewatering characteristics, but can be readily thickened to 6 percent solids. This sludge is currently disposed of by lagoon storage (L-1).

With natural recarbonation, the resultant highly alkaline effluent (pH = 12.2) containing 700 to 750 ppm lime (as $Ca(OH)_2$) first undergoes neutralization by surface absorption of atmospheric CO_2 to pH 10.2, accompanied by precipitation of nearly all the remaining calcium in the inlet section of the stabilization basin (B-1). Biochemical oxidation results in further neutralization and overall BOD and COD reductions of 98 and 95 percent respectively. Clarifier sludge load totals about 30 tons per day, of which thirty percent represents added lime.



Lime Mixing Tank and Primary Clarifier

The use of a recarbonation process instead of relying upon absorption of atmospheric CO_2 was investigated on pilot scale to obtain preliminary design data. Figure 2 shows the pilot flow sheet. Decolorization clarifier (C-1) overflow enters a carbonator (R-1) providing 16 to 20 minutes residence time, receiving scrubbed lime kiln stack gas at 180°F. Following clarification (C-2) at a rise rate of 2.5 gal. per minute per sq.ft. residual calcium level is reduced to 1 lb $CaCO_3$ per 1000 gallons. This can be further reduced by 50 percent if the lime kiln gases are pretreated with mechanical cyclones alone and enter the carbonator at 325°F instead. Recarbonation at this point adds approximately 10 tons of sludge solids which would otherwise be precipitated in the stabilization basin to the 30 tons obtained during decolorization and improves overall dewatering characteristics. The additional sludge is of high purity however, and it could be introduced to the lime recovery cycle. Reduction in pH by a recarbonation process would probably extend the effectiveness of the quiescent biochemical oxidation lagoon since a portion of the capacity is now required for neutralization by absorption of atmospheric CO_2.

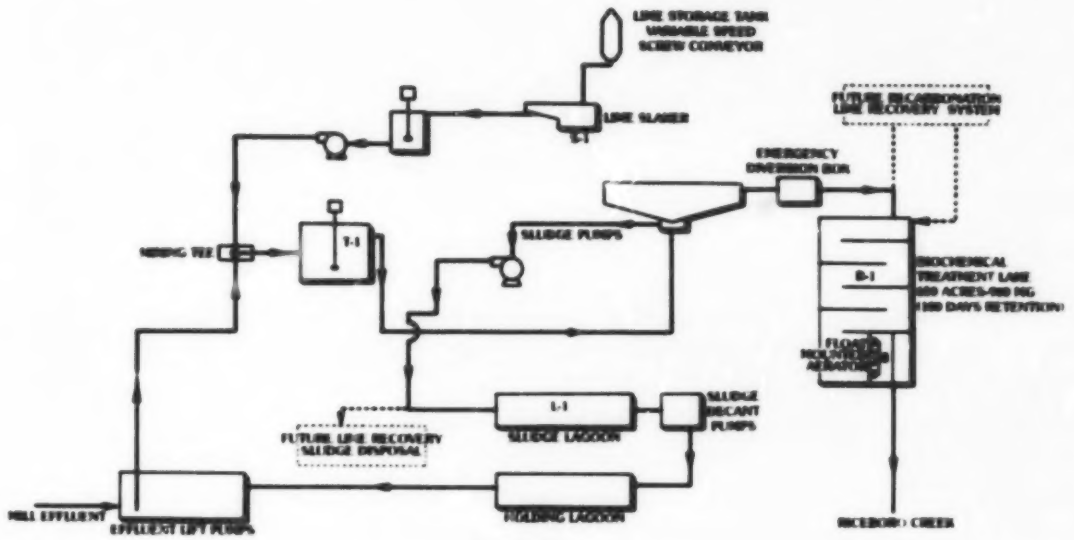


FIGURE 1
FULL SCALE DECOLORIZATION SYSTEM

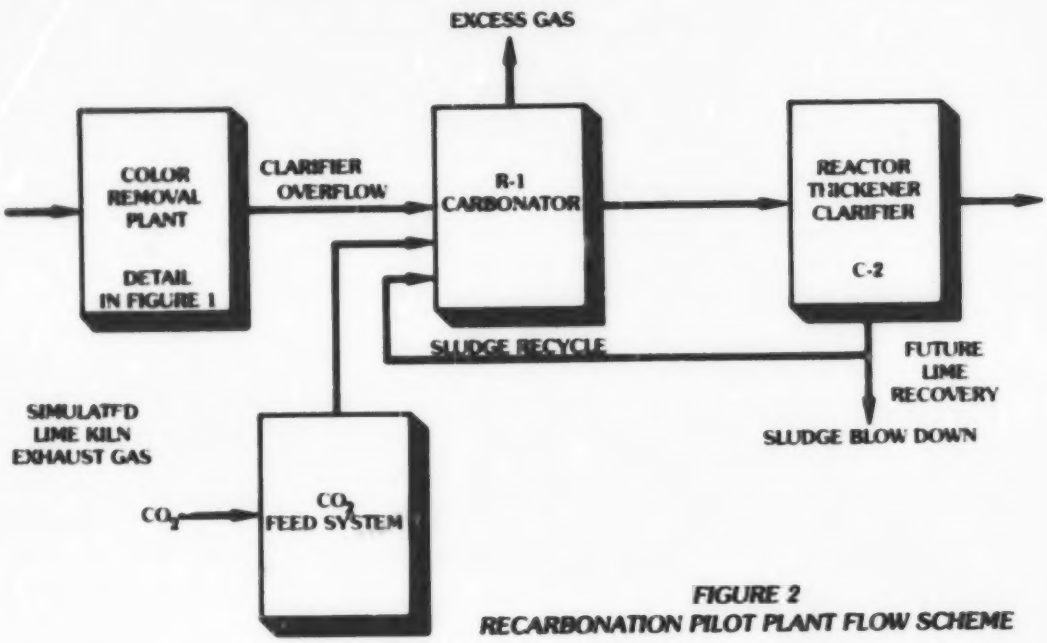


FIGURE 2
RECARBONATION PILOT PLANT FLOW SCHEME

3. THE OLD vs. THE NEW EFFLUENT

TYPICAL EFFLUENT COMPOSITIONS AT INTERSTATE PAPER CORPORATION RICEBORO, GEORGIA MILL

(All Data in lbs. per ton Pulp/Board unless otherwise noted.)

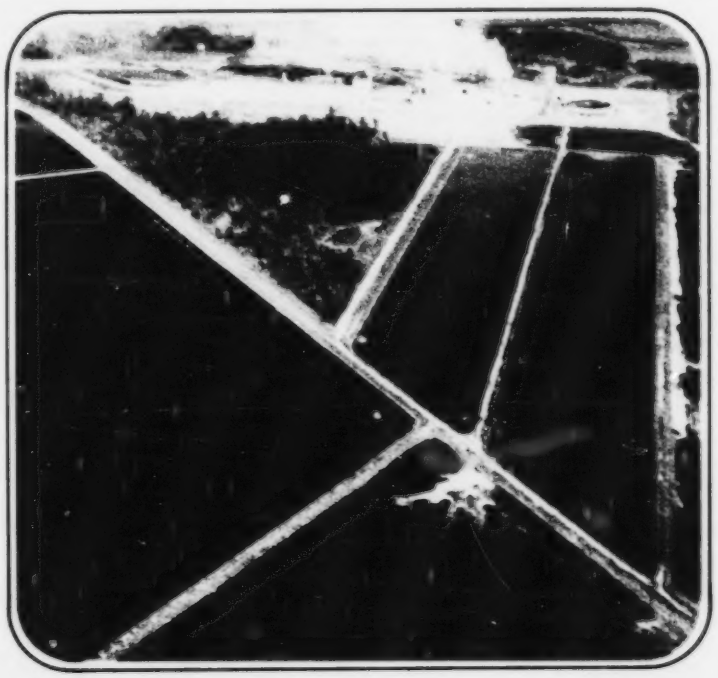
	Estimated Overflow from Primary Clarifier without Lime Treatment	Overflow from Primary Clarifier with 1000 ppm $CaCO_3$ Lime Dosage	Final Effluent at Interstate Paper after Lime Treatment plus Natural Recarbonation and Biological Treatment in Stabilization Basin
Flow (Gal/Ton)	15000	15000	15000
pH	8.5-9.5	12.2	7.5-8.5
Suspended Solids	5.0 (40 ppm)	1.25 (10 ppm)	1.25 (10 ppm)
BOD	41 (330 ppm)	28 (220 ppm)	.6 (5 ppm)
COD	121 (970 ppm)	66 (525 ppm)	6 (50 ppm)
Color, APHA Units	1200	125	125
Calcium as $CaCO_3$	<6 (<50 ppm)	125 (1000 ppm)	4 (35 ppm)
Sludge Solids	105	150	255*

*Includes estimated Sludge deposited in Stabilization Basin during Natural Recarbonation

4. THE ECONOMICS

Construction costs for the decolorization portion of the treatment facilities totalled $481,600 including land. These costs covered site development, lime slaking, storage and feed control facilities, flocculation, a portion of the clarification unit and sludge storage facilities costs, project engineering, and construction supervision. First year operating costs for chemicals, power, labor, and plant overhead totalled $289,000 with lime costs estimated at $15.35 per ton lime (as 90 percent CaO). First year special study costs including administration, contingencies, system revisions and post-construction studies and reports totalled $133,100. These special study costs are not included in the economics presented. (2) A major portion of the operating costs is accounted for by the non-recovered lime, including that separable by treated effluent recarbonation, as well as the lime present in the settled sludge.

The grant at Interstate did not include testing these modifications. The potential for raw material savings by recovery of the lime used is valued at approximately $78,000 annually as lime rock or $0.56 per ton of pulp/board. Lime recovery would increase fixed maintenance, labor, and power costs and decrease chemical and long term sludge disposal costs.



Aerial View of Sludge Lagoons and Effluent entry into Oxidation Pond.

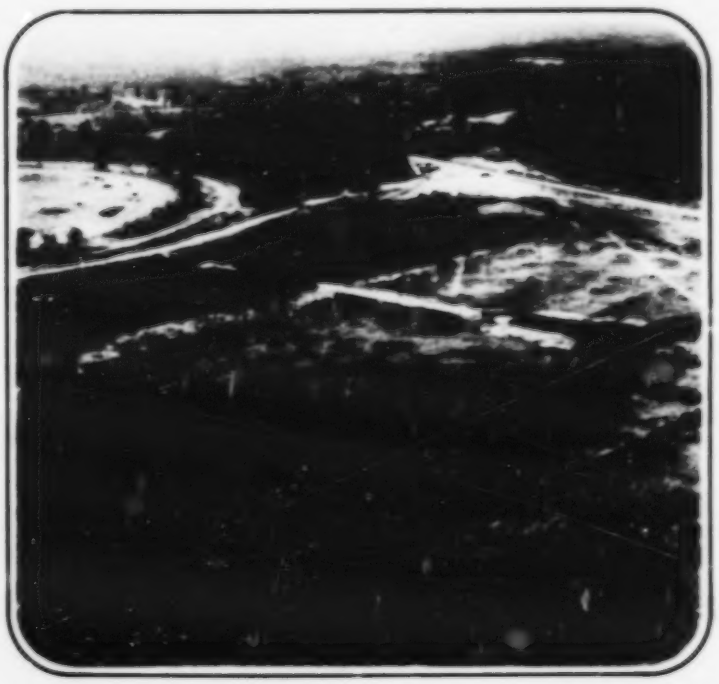
140,000 NOMINAL TONS/YR (197,000 TONS/YR ACTUAL)
OF
UNBLEACHED KRAFT PULP

TOTAL INVESTMENT		
(including engineering, excluding land)		$455,000
operating costs (all cost in $/Yr)		
I Wages (operator/shift plus allotted supervision and technical assistance)		71,000
II Electric Power (288 hp, including lift station, at 8 mils)		14,000
III Maintenance		30,000
IV Laboratory (included in Technical Assistance)		
V General Plant Overhead		45,000
VI Raw Materials Lime ($15/Ton)		129,000
	TOTAL OPERATING COSTS	289,000
FIXED CHARGES		
Depreciation @ 10 years		45,000
Interest on Loan @ 9%		41,000
Taxes, Insurance		9,000
	TOTAL FIXED CHARGES	95,000
	NET YEARLY COST TOTAL	384,000
	OPERATING COST=$1.47/ton pulp	
	TOTAL COSTS=$1.95/ton pulp	

5. AREAS OF APPLICATION

The process as described, and with the potential for adding features for lime recovery, believed directly applicable to unbleached kraft mills. This process with lime recovery is currently being applied to the Continental Can unbleached kraft mill at Hodge, Louisiana.

The process might also find application at bleached kraft mills where use of lime precipitation techniques on the heavily colored caustic extraction stage effluent prove inadequate to accomplish the desired degree of decolorization. It might also find application in treating the mixed color-containing mill effluents from a bleached kraft pulp mill, particularly where acidic effluent neutralization is required prior to biological treatment.



Aerial View of Aeration Basin at Outfall into Receiving Stream

FOR FURTHER INFORMATION:

DETAILED INFORMATION ON THIS PROJECT, INCLUDING EQUIPMENT LIST, IS AVAILABLE FROM THE SUPERINTENDENT OF DOCUMENTS AS EPA REPORT 12040 ENC "COLOR REMOVAL FROM KRAFT PULPING EFFLUENT BY LIME ADDITION"

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